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N^o. X.MEMOIR of JONATHAN WILLIAMS, *on the use of the Thermometer in discovering Banks, Soundings, &c.*

Read Nov.
19, 1790.

I HAVE hitherto delayed making a public communication of my sea journals, from an apprehension of being thought too forward in calling the attention of the Philolophical Society to the subject of them; but being impressed with a belief, that by noticing the changes in the heat of the sea water, a navigator might always know when he is in soundings, and thereby be able to escape the dangers arising from unexpected currents, and erroneous reckoning, I cannot think myself justifiable in longer hesitating to submit my remarks to their learned and judicious examination.

This sense of duty is strengthened by the recollection of many melancholy instances where mariners, in full confidence of being at a distance from land, have, with crowded sails, rushed on to destruction; and I was once within half an hour's time of being shipwrecked on the rocks of Scilly, when the return of day presented to our view the dreadful fate we had so narrowly escaped.

If it should be found that the use of the thermometer would be an improvement in the art of navigation, I shall be abundantly rewarded by the reflection of having contributed to the service of humanity, which is the common cause of all men. If it should, on the contrary, appear that I am mistaken, either in the facts or the conclusions deduced, I trust that the desire of doing good, the only motive that actuates me, will meet with indulgence from every candid mind.

In the months of August and September, 1785. I was a fellow passenger with the late Doctor Franklin from Europe to America, and made, under his direction, the experiments

periments mentioned in his description of the course of the gulph stream, an account of which was annexed to his maritime observations, and published in the Philosophical Transactions Vol. II. page 328, I then determined to repeat these experiments in my future voyages. Accordingly on a passage from Boston to Virginia in October 1789, I kept a journal of the heat of the air and water at sunrise, noon and sunset; I then noticed that the sea water out of soundings was about ten degrees warmer than that on the coast, and it very naturally occurred to me that the thermometer might become an useful nautical instrument to indicate an approach to the shore. I thought it prudent, however, to keep this idea to myself till after I had made a course of fair and repeated experiments, which I accordingly did during four passages, 1st, the one from Boston to Virginia abovementioned, 2d, from Virginia to England, 3d, from England to Hallifax, and 4th, from Hallifax to New-York. By consulting these journals and the observations made at the dates written, together with the tracks of the ship's way marked on the chart annexed, it will not only appear that Doctor Franklin's account of the warmth of the gulph stream has been amply confirmed, but also that banks, coasts, islands of ice, and rocks under water, may be discovered when not visible, and when the weather is too boisterous to sound, with no other trouble than dipping the thermometer into the sea water. It is well known to sailors, that the water on the banks of Newfoundland is cold, but as they only try this, with the hand, their remarks are contradictory owing to the varied temperature of the hand, and I never heard of any further application of what they think merely a matter of curiosity. Doct. Franklin's observations had the knowledge of currents for their object, and this extension of his discovery did not occur; but as I am indebted to his instructive conversation and example, for my inducement to pursue

philosophical researches when in my power to do so, he may be considered as the original author of what is now presented for examination.

It will be proper to suspend any conclusions till the journals have been attentively considered, but as a guide to the object of them, it may not be amiss to state such facts as it is presumed the experiments have a tendency to establish.

1. The water over banks is much colder than the water of the main ocean, and it is more cold in proportion as it is less deep.

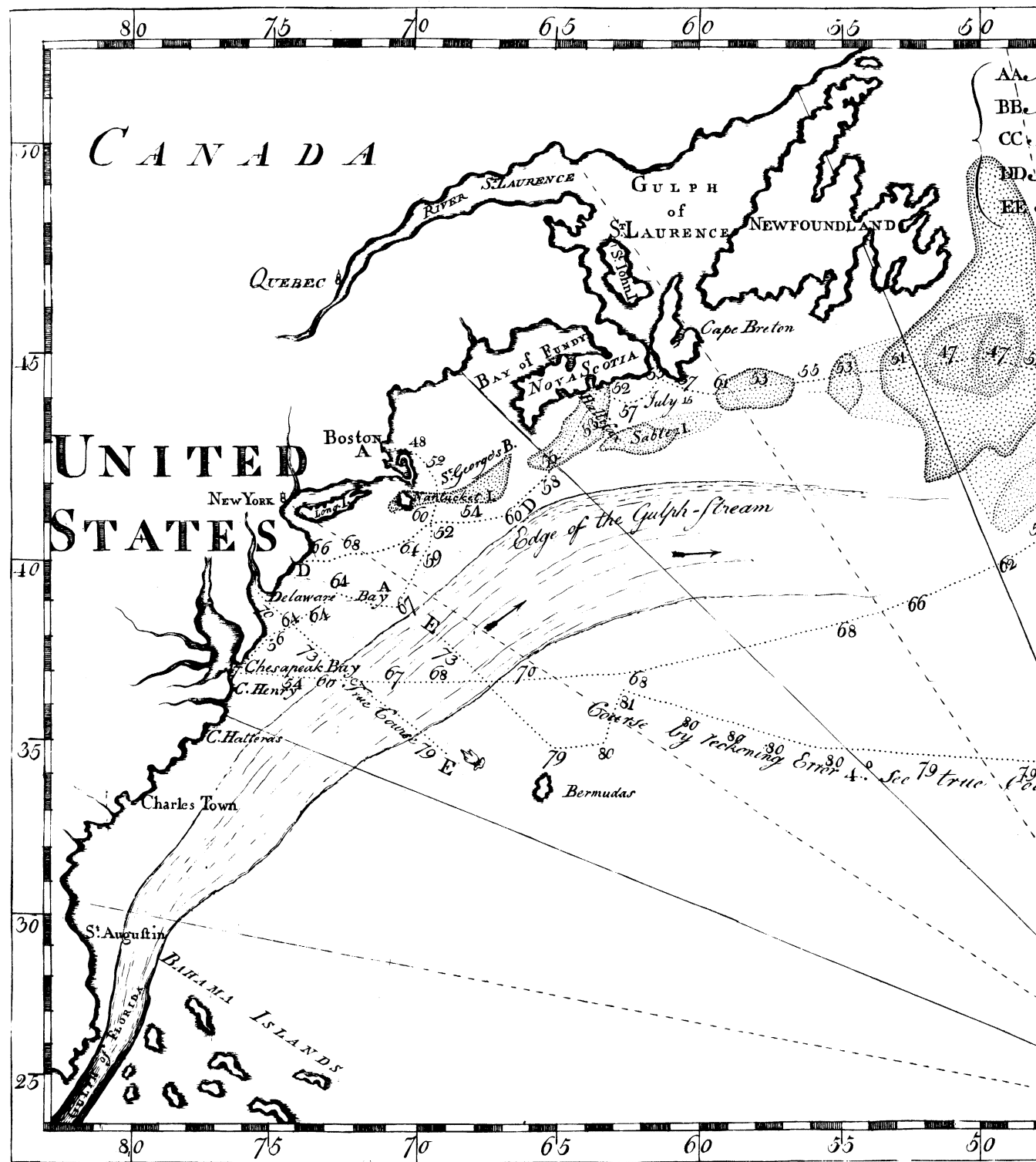
2. The water over small banks is less cold than that over large ones.

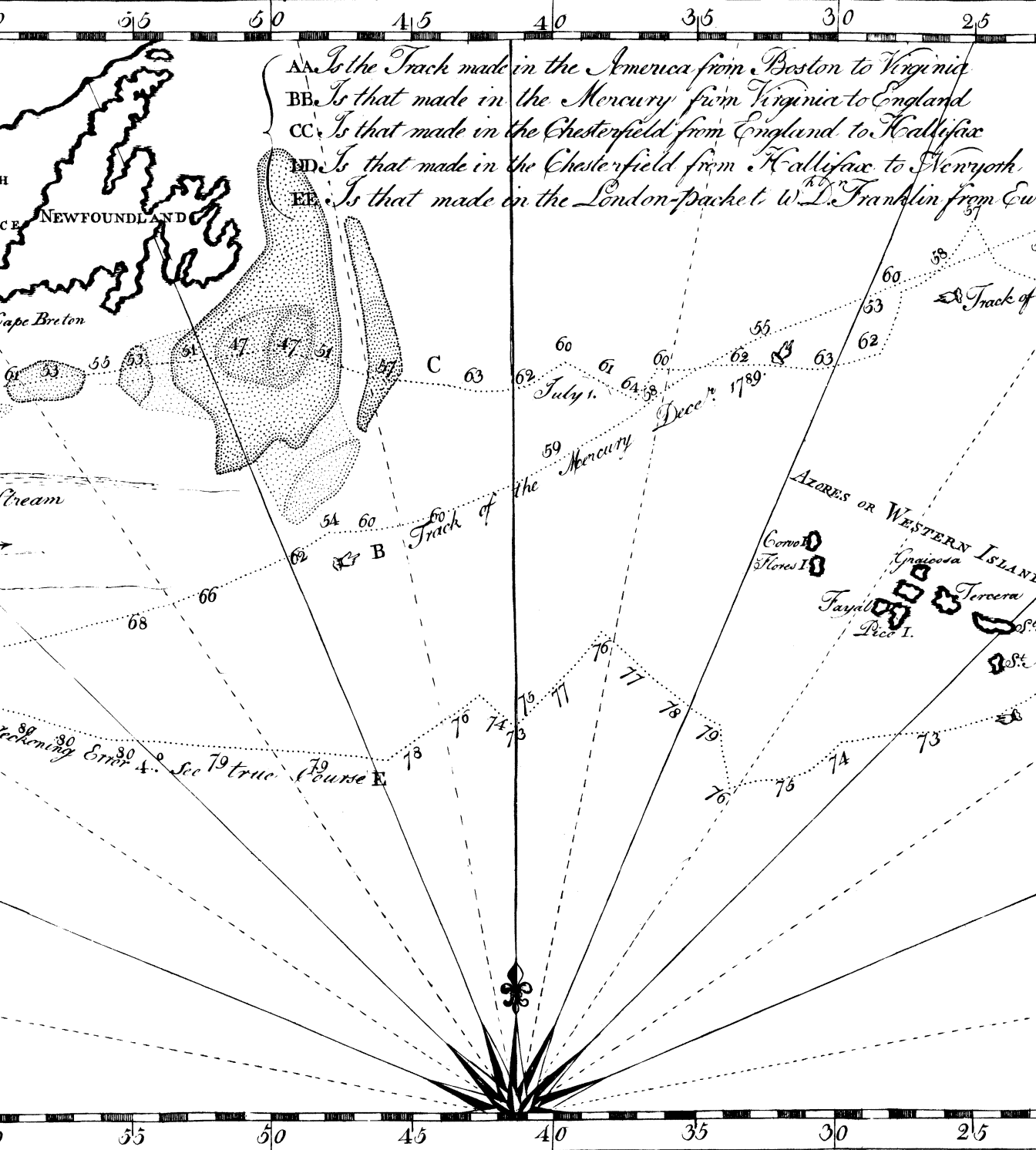
3. The water over banks that are near the coast is warmer than that over banks far distant, but it is colder than the adjacent sea.

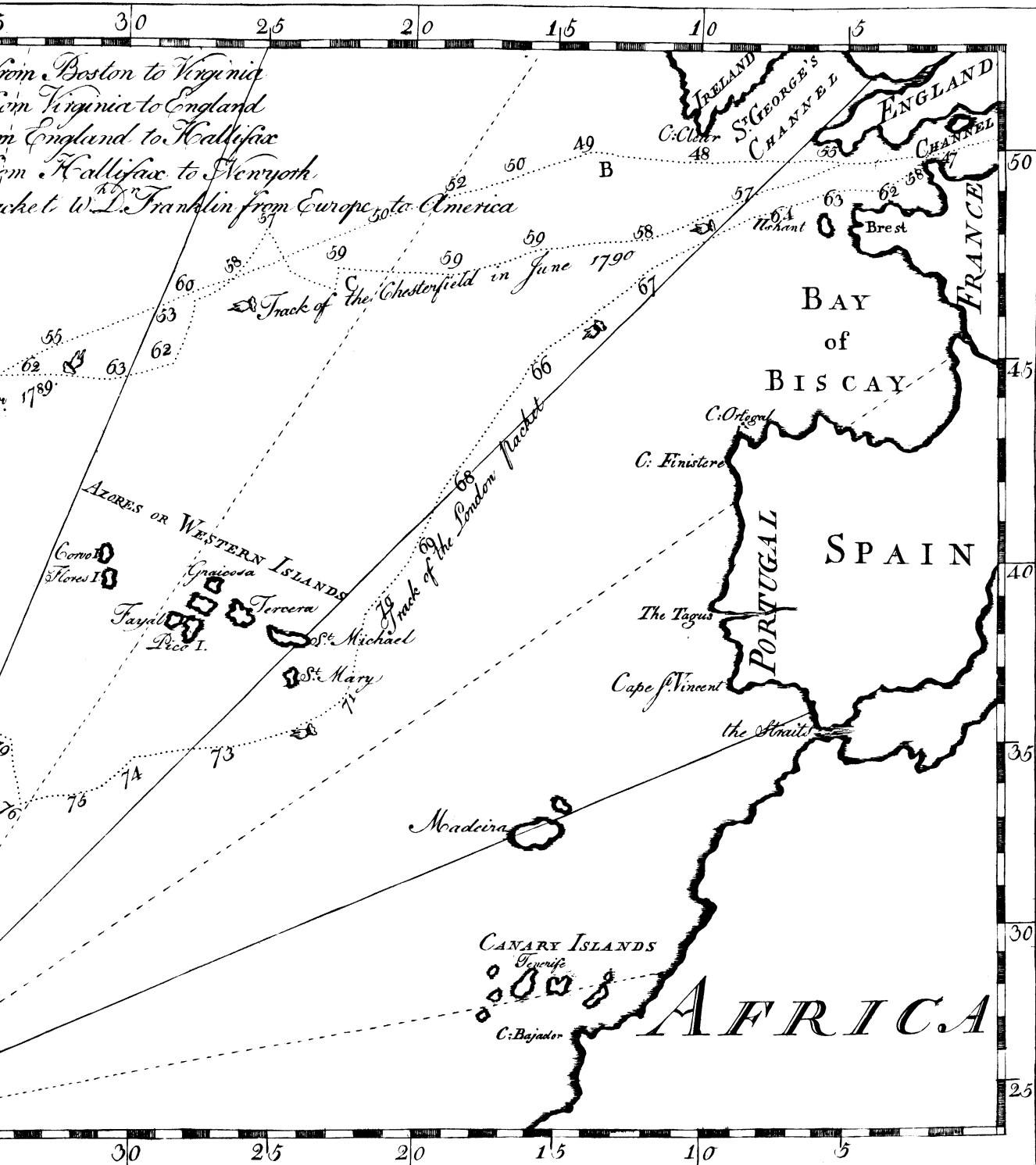
4. The water over banks of the coast, *i. e.* those immediately connected with the land above water, is warmer than that over those which admit deep water between them and the coast; but still it is colder than the adjacent sea.

5. The water within capes and rivers does not follow the above rules; it being less agitated, and more exposed to the heat of the sun, and to receive the heat from the circumjacent land, must be colder or warmer than that in soundings without, according to the seasons, and temperature of the atmosphere.

6. The passage, therefore, from deep to shoal water may be discovered by a regular use of the thermometer, before a navigator can see the land; but as the temperature is relative, no particular degree can be ascertained as a rule, and the judgement can only be guided by the difference. Thus in August I found the water off Cape Cod to be 58° by Fahrenheit, and at sea it was 69° ; in October the water off Cape Cod was 48° , and at sea it was 59° . This difference was equally a guide in both cases, though the heat was different at different seasons.







I do not presume to say what is the cause of this difference of heat between the sea and bank water, but if a navigator were to observe it when near an Island of ice, he would very naturally say that the ice conducted the heat from the circumjacent water, and left it colder than that at a distance. And as it is well known that stones and sand are great conductors of heat, it seems probable that banks also conduct the heat from the adjacent water, though not so rapidly as the ice. The heat of the water may indeed be supposed to seek its equilibrium, but as long as the Islands of ice and banks continue to conduct, there must be some difference, and this it is, which, by attention, may be made a faithful sentinel to give an alarm when danger is near.

I have thought it my duty to present my journals as they were written at sea, to avoid the suspicion of having added any thing from the suggestions of the imagination. While this will be received as a circumstance favourable to the truth of them, I hope it will also operate as an apology for their many imperfections.

The journal A. from Boston to Virginia, shows that the water on the coast of Massachusetts, was at 48° ; at sea between that coast and the stream, 59° ; in the gulph stream at its edge, 67° ; between that, and the coast of Virginia farther southward 64° ; and in soundings on that coast, 56° . At that season (in October, just after the warm weather) the water grew warmer as we approached the land.

The journal B. from Virginia to England, shows that in December, the water in the coast of Virginia, was at 47° ; between the coast and the stream, 60° ; and in the stream, 70° . This current being in our favour, we did not avoid it, and the water continued with little variation, till we came near the banks of Newfoundland, when the thermometer fell from 66 to 54; passing these, it rose again
to

to 600° , and then continued a very gradual descent as we went to the Northward; 'till we struck soundings, when it was at 48° .

It may be here observed, that the decrease in the heat of the water was so gradual as to give but one degree in a days run, while in going to, or coming from the coast of America, the thermometer will alter 8 or 10 degrees in a few hours run. It is well known, by sounding, that the English coast extends with a very gradual descent to a great distance. It is also known that the American coast does not extend very far, and the water is suddenly deep. Let these facts be compared with the changes in the thermometer, on the two coasts, and they will agree with what has been said about the usefulness of that instrument.

It may be observed in Doctor Franklin's journal on board of the *Reprisal*, that in November 1776, when near the banks of Newfoundland, his thermometer fell ten degrees, though considerably to the Southward of them, and after passing them, it rose nearly to its former state: the Doctor did not make any observation on this circumstance; but it agrees with my journal, in nearly the same, place made nine years afterwards.

The journal C. from England to Hallifax, shows the changes in the heat of the water as we sailed over banks and deep water alternately, with an accuracy that I confess, exceeded my expectation, the land appearing as the thermometer indicated our approach to it.

The journal D from Hallifax to New-York not only shows the variety of depths we passed over, but indicates the inner edge of the gulph stream. As by the thermometer and soundings it appeared to me that the ship was a head of the reckoning, I made allowances for the eddy current of that stream in our favour, and comparing these with the chart, I noted in the journal, the longitude I thought we were in, under that calculated by the ship's officers :

officers : what encouraged this opinion, was the disagreement between the soundings by the lead, and those marked on the chart in the places where, by the common reckoning, the ship was supposed to be ; while upon the other supposition they both agreed. When we made the land this latter reckoning turned out accurate, and I won a small bett of the Captain who candidly acknowledged the usefulness of the thermometer, and declared that he would in future always have one on board.

Finding the coast of America to grow suddenly deep as it approaches the gulph stream, and finding continued soundings from Cape Sable to New-York, I am induced to believe that it has its shape according to the course of that current, and that it is connected in a sweep from the banks of Newfoundland to Florida, the various banks between being only eminences of the coast. If my apprehension of the accuracy of thermometrical observation is well founded, it would be an easy thing to make a general survey of the coast under water, more particularly than has hitherto been, or could be done by sounding.

On the chart annexed the tracks of my several passages are marked with the daily heat of the water in degrees according to Fahrenheit, by which the variations on the approach to land may be seen at one view. The edge of the gulph stream is also traced according to the experiments as far as the banks of Newfoundland : how far it runs to the eastward I do not pretend to say ; but having found a current in the natural direction of its sweep among the western islands, I am inclined to think it extends so far, before it turns off to the southward. It may be observed, however, that as this stream, like all other currents, must be affected by tempests on either side ; it may, as these prevail, run somewhat nearer or somewhat farther distant from the coast.

In confirmation of what has been said about the eddy current of the gulph stream, I have extracted from the journal of an officer belonging to the British ship of war Liverpool, some observations which describe this eddy on both sides of the stream * two other extracts from the same journal † describe a current among the western Isles, which is perhaps the gulph stream then turning to the southward. This journal was communicated to me by Capt. Schuyler of the British packet, on board of which I made my last experiments and observations.

‡ In addition to my journals I have subjoined an account of some experiments on fish which show that their animal heat was 16° degrees colder than the water at the surface; from which it may be supposed that the water at bottom is in proportion colder than that above. It may be naturally suggested, that trying the heat of the water at the surface, (the only way in one's power when sailing rapidly through it,) is too inaccurate to be depended on, since the surface must be heated by the atmosphere. To this it may not be amiss to answer.—1. That by repeated experiments at the depth of 30, 40, and 60 fathom I have found the water below, out of soundings, to be no more than six degrees colder than that above; and at four or five fathoms depth, when the sea was agitated, there was no difference worthy notice. 2. When the sea is not agitated and the surface, by being exposed to a hot sun, is warmer, the weather being calm, it is easy to have water from a considerable depth; this I have found to make a difference of one or two degrees only, and it is easy to make the allowance. 3. The difference of heat which marks an approach to land is sufficiently sensible at the surface for the purpose of giving notice of danger, I have generally found it to be 6° in three hours run, and long before we
were

* Appendix N^o. I.

† Appendix N^o. II and III.

‡ Appendix, N^o. IV.

were near enough for to be in danger. Upon the whole, as it is fact, and not argument which should inspire belief, I wish every doubting navigator to endeavour to confute me by making other experiments, and thereby, if he can, detect the fallacy of mine.

JONATHAN WILLIAMS, JUN.

These Journals, as they were presented to the Society, contained the experiments in detail; but it was thought expedient in the publication of them, to suppress all those, which, by having nearly similar results, may be considered as repetitions of the preceding, or gradual approaches towards the succeeding ones. The reader may depend, however, that nothing is altered, and that the heat of the water was taken at least three times every day during all the voyages, and when puffing over banks, or approaching the coast, almost every hour, as well by night as by day. N. B. The Thermometer used was on Fahrenheit's Scale.

A. A Thermometrical Journal of the temperature of the Atmosphere and the Sea on a Passage from Boston towards Virginia; on board of the Schooner America, Capt. Brace, by JONATHAN WILLIAMS. Jun.

Dates. 1789.	Time.	Places at Noon.		Temperature of		Notes.
		Lat. N.	Long. W.	Air.	Water.	
Oct. 11, 12,	Sun fet.	42° 5'	69° 40'	58.	48.	October 11, fun fet. Sailed at 8 A. M. from Boston, and at fun fet, we were off Cape Cod, which is in lat. 42. 5. N. and long. 69. 40. W. from London. See John Hamilton Moore's practical navigator.
	Sun rife.			50.	54.	
13,	Noon.	40 23.	68 46.	52.	52.	October 12, noon. No symptom of the gulph stream in this longitude. being 7° warmer than at noon.
	Sun fet.			52.	59.	
14,	Sun rife.			57.	65.	October 13, fun fet. We now probably approach the gulph stream, the water being 12° warmer than at noon.
	Noon.	38 40.	70 35.	60.	67.	
15,	Sun fet.			64.	66.	October 13, noon. We are now probably within the stream, the water being 15° warmer than yesterday at this time.
	Sun rife.			65.	62.	
16,	Sun fet.	38 46.	71 58.	69.	61.	October 13, fun fet. We had a good observation at noon; we are probably still in the stream, the water continuing warm.
	Sun rife.			66.	64.	
17,	Noon.	38 25.	73 10.	70.	65.	October 14, fun rife. We have made about a west course during the night, distant about 52 miles.
	Sun fet.			67.	64.	
18,	Noon.			59.	63.	October 14, noon. It appears by observation that we are 18 miles north of our reckoning; hitherto our reckoning has appeared accurate.
	Sun rife.	37 45.	73 40.	60.	64.	
19,	Sun fet.			61.	64.	October 14, funlet. The water yesterday noon was 6° warmer than at the same time to day, yet the air was 9° warmer to day than at the same time yesterday. By this difference of temperature, and by the loss of 18 miles distance, it is probable that we were within the stream yesterday and carried to the Northward by its current; thus it appears that in the lat. 38° 43' N. the western edge of the stream extends as far as long. 71. 15 W. which is the mean between yesterday, and to days reckoning.
	Sun rife.	37 36.	74 1.	66.	64.	
20,	Sun fet.			60.	57.	October 16, noon. I sent a well corked bottle 30 fathoms deep, and drew it up empty. I sent it again 60 fathoms deep, and drew it up full, this water was then taken at a depth somewhere between 30 and 60 fathoms and it was by the thermometer at 58° six degrees colder than at the surface 64°.
	Sun rife.	37 34.	74 45.	60.	57.	
21,	Noon.			56.	56.	October 16, noon. I sent a well corked bottle 30 fathoms deep, and drew it up empty. I sent it again 60 fathoms deep, and drew it up full, this water was then taken at a depth somewhere between 30 and 60 fathoms and it was by the thermometer at 58° six degrees colder than at the surface 64°.
	Sun rife.	37 4.	76 4.	58.	58.	

October 17, noon. Observe how regular the temperature of the water has been during 4 days, i. e. since leaving the stream.

October 18, fun rife. By the sudden change in the heat of the water, I suspect we are drawing near foundings.

Noon. Sounded, but no bottom, with 60 fathoms of line. No observation for the first time since we have been out.

At 8 P. M. got bottom 33 fathoms heat of water 56°; at midnight 21 fathoms.

October 19. At 2 A. M. 18 fathoms at 4 A. M. 14 fathoms at 8 A. M. made Cape Charles W. N. W. at 9 Cape Henry, W. by S. W. off W. loughly's point in the mouth of James River.

Cape Charles by John Hamilton Moore's practical navigator is in lat. 37°. 9 N. lon. 75°. 50 W. We are now about 16 miles within the Cape, thus the reckoning proves to be very accurate.

N. B. The water appears somewhat warmer in shoal, than in deep foundings.

MARITIME OBSERVATIONS.

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B. A thermometrical Journal of the temperature of the atmosphere, and the sea, on a passage from Virginia to England, on board of the Brig Mercury, Captain Thompson, by J. W.

1789. Dates.	Time	Places in at Noon		Temperature of		NOTES.
		Lat. N.	Lon. W.	Air.	Water.	
Nov. 30.	noon	37° 0'	75° 43'	42°	47°	Nov. 30. Sailed this morning from Hampton Road; at noon Cape Henry bore West dist. 2 leagues.
	sun set			42	50	
Dec. 1.	sun rise			42	54	
	noon	36 30	71 2	44	60	Dec. 1. Entered the Gulph Stream, at 10 P. M.
	10 P. M.			50	70	
2.	sun set	36 30	68 47	58	67	
3.	noon	36 30	65 39	60	70	
	sun set			63	71	
4.	sun rise			59	69	
	noon	37 3	62 13	60	68	
	sun set			59	67	
5.	8 A. M.			56	66	
7.	sun set	38 7	54 4	66	68	
8.	noon	38 43	52 12	68	66	
9.	sun rise	39 56	48 52	66	62	
10.	sun rise			46	54	I suppose this coldness to be owing to the Banks of Newfoundland, which are in this Longitude.
	noon	40 10	46 12	54	60	
	sun set			52	62	
11.	noon	40 44	43 39	56	60	
13.	noon	42 22	39 35	62	59	
14.	sun rise	43 54	36 04	61	58	
15.	sun rise			58	57	Dec. 22. Since the 16th there has been little or no alteration till to-day.
	noon	44 58	32 27	60	55	
16.	noon	45 58	29 00	56	53	
22.	sun rise	48 22	21 02	48	50	Dec. 25. At 8 P. M. founded in 75 fathoms.
24.	midnight	49 48	13 54	46	49	Dec. 27. At noon founded in 40 fathoms.
25.	noon	49 40	10 14	48	48	
27.	noon	49 56	3 32	58	49	
28.	noon	50 24	2 22	50	49	Dec. 28. At noon saw Portland

M 2

C. A

MARITIME OBSERVATIONS.

C. A thermometrical Journal of the temperature of the atmosphere and the sea, on a passage from Falmouth in England, to Halifax in Nova-Scotia, on board of the British Packet *Chesterfield*, Captain Schuyler, by J. W.

Dates. 1790.	Time	Places in at Noon.		Temp. of		Notes.
		Lat. N.	Long. W.	Air	Wat.	
June 12	Noon.	49° 57'	5° 14'	61°	55°	
	6 P. M.			57	57	
14	Noon.	48 11	12 18	61	58	
15	8 P. M.	47 25	16 16	60	59	
21	Noon.	48 7	25 16	62	57	
22	8 A. M.	47 19	26 11	59	58	
23	Noon.	46 38	27 55	62	60	
24	6 P. M.	45 13	28 29	64	62	
25	Noon.	44 46	30 32	67	63	
26	7 P. M.	44 53	32 15	66	62	
27	Noon.	44 51	33 29	63	61	
30	Noon.	44 56	36 21	64	60	
July 1	Noon.	44 0	37 2	66	64	July 1. In the evening, I strained a bucket of water through a towel, and the luminous appearances so common in the sea, remained upon the cloth.
2	8 P. M.	44 31	38 25	65	61	
3	8 P. M.	44 52	39 56	62	60	
4	Noon.	44 23	40 53	66	62	
5	6 P. M.	44 20	43 25	66	63	
6	6 A. M.			66	62	
	Noon.	44 43	46 7	62	57	
	1 P. M.			62	55	
	4 P. M.			58	53	
	5 P. M.			55	51	I suppose we are on Jacquet's Bank.
	6 P. M.			60	56	
	7 P. M.			59	57	I suppose we are between Jacquet's and the Grand Bank of Newfoundland
	Midnight			59	55	These irregular degrees of heat indicate eminences in the valley between Jacquet's and the Grand Bank.
7	4 A. M.			58	54	
	6 A. M.			56	50	
	7 A. M.			56	49	
	10 A. M.			56	51	
	11 A. M.			55	53	
	Noon.	45 00	47 57	55	51	
	6 P. M.			55	49	
8	6 P. M.	45 14	49 13	53	47	
9	8 A. M.	45 10	51 9	53	47	Sounded in 40 fathoms.
10	8 A. M.	44 54	53 39	57	51	Do. in 45 do.
11	8 A. M.	44 52	54 57	58	53	Do. in 56 do.
	6 P. M.			60	54	Do. in 75 do.
12	8 P. M.	44 49	56 16	55	55	do. no bot. in 110 F. over the G. Bank.
13	8 A. M.	44 30	58 28	55	53	Do. in 42 perhaps on the whale bank
	8 P. M.			56	54	Do. 40 fathoms.
	10 do.			56	53	Do. 35 do.
14	8 A. M.			60	56	Do. 38 do.
	Noon	44 33	59 54	60	61	Do. 60 do. calm and bright Sun.
	Midnight			57	57	
15	2 P. M.	44 50	61 20	60	57	Saw land.
	5 P. M.			60	53	Tack'd, stood off land, found. 13 fath.
	8 P. M.			60	56	Land out of sight.
16	Noon	44 34	62 17	61	57	Standing in for the land.
	8 P. M.			60	53	Tack'd and off the land.
17	6 A. M.			59	52	On Jeddore Bank.
	Neon			62	57	Off the Bank.
18	4. A. M.	At the mo. of Hal. H.		54	52	

Observations on a passage from Falmouth to Halifax by Jonathan Williams.

- June 17,
1790,
July 6,
lat. 44. 43. N.
lon. 46. 07. W.
- The very gradual increase in the heat of the water as we leave England indicates a small descent of the coast, which, as far as soundings go, is known to be the case.
- Here we find a sudden change of 7 degrees in the heat of the water, which indicates our approach to the Banks of Newfoundland, though not in such soundings as we could obtain.
- We tried with 160 fathoms but the lead was only about 12 pounds, and the line was a very thick one: perhaps the line floated the lead. At 5 P. M. the water was still colder 4 degrees; but at 8 A. M. it grew warmer again 6 degrees, this seems to indicate a passage, over a bank, into water as deep as when we discovered the first change.
- July 7,
lat. 45. 00. N.
lon. 47. 57 W.
- We are now in cold water again. (49) 13 degrees colder than the ocean water had regularly been during 12 days previous to the first change, except only the small variations of a more northern or more southern course, these changes seem to indicate our entrance on another bank. There is a bank laid down in the charts, by some called Jaquet's bank, but by the older charts called false bank, over which we have probably passed. In this longitude, but farther south, both by Dr. Franklin's and my own observations, the water grew suddenly cool. This seems to confirm the supposition of this outer bank, the southernmost point of which I suppose to extend as far as lat. 40. 00. N. We hove too in order to try the soundings but the force of the back sail carried away the main top mast head, and brought the top gallant sail, mast and rigging down, this confusion interrupted the sounding; and we had only 80 fathoms of line out, when it was hauled in.
- July 8,
lat. 44. 49. N.
lon. 56. 16. W.
- At 6 P. M. the water was only 2 degrees colder (47°) than when we were interrupted in sounding, and we got bottom in 40 fathoms.
- From the last found to this time the thermometer has varied, regularly as the soundings varied, the water being warmer when deeper, and cooler when shoaler. It is now at 55, which is 8 degrees warmer than when we had 40 fathoms. We now sounded and could not reach bottom with 110 fathoms of line. This indicates that we are off the grand bank, and within it. By taking our distance from the time the thermometer first fell to 54, to the last time it stood at that degree, we may give an account of the width of the soundings on this grand bank, though it probably extends much farther, but in deeper water. This is noted on the chart. The variations in the thermometer between last night and this morning, indicate our passage over an eminence of the bank, called the Whale Bank, situated on its inner edge.
- July 13,
lat. 44. 30. N.
lon. 58. 28. W.
- Thermometer at 8 A. M. was at 53, two degrees colder than when we could not reach bottom with 110 fathoms of line: and we sounded in 42 fathoms. This indicates our entrance on another bank, which is called in the charts Banquereau. It is observable that the water of small banks is not so cold as that of large banks, and this seems natural, if it is supposed that the conducting power of the land, taking away part of the heat of the water, is the cause of the changes in the thermometer; for that power must have less effect, as the quantity of the ground under water is less: and this must be still more remarkable when the bank is immediately connected with land above water, for such land conducting heat away from the atmosphere, and receiving much from the sun, must require less from the water. This remark has been uniformly confirmed in all my experiments within capes, where the water is much warmer than in soundings without them. And it is further observable, that the water on the coast of America on the edge of soundings, is not above 6 or 8 degrees colder than deep water; but on the banks of Newfoundland it is from 12 to 15 degrees colder.
- July 14,
lat. 44. 33. N.
lon. 59. 54. W.
- Here we have the water 57, which is 2° warmer than when we could not get bottom between the banks, yet we have 65 fathoms, at noon it was up to 61, and we had the same soundings; but as it was calm weather, and as we had a hot sun, allowance must be made for its influence, and therefore no certain conclusion can be drawn. The depth of the water however indicates our going off Banquereau, and the white sand of the bottom indicates that we are on the edge of the bank which is connected with the Isle of Sable. This also accounts, from the above mentioned principle, for the unexpected warmth of the water.
- July 15,
lat. 44. 50. N.
lon. 61. 20. W.
- We saw the land at 2 P. M. and now we are in 13 fathoms of water thermometer 53. This land agrees with the description of that about St. Mary's river, and tracing our course back, shews us to have been last night, and the preceding days, in the very places indicated by our reckoning, thermometer, and soundings. We tacked and stood off.
- July 18, off
Halifax Harbour:
- The thermometer, when we stood off the land, rose up to 57, and when we came on and made the high lands of Jeddore it indicated Jeddore banks by falling to 52, when being becalmed we caught fish, leaving the bank it rose to 57, and now we are in sight of our port it stands at 52.

D. A thermometrical Journal of the temperature of the atmosphere at sea on a passage from Halifax to New-York, on board of the British Packet *Chesterfield*, Captain Schuyler.

Dates. 1790.	Time	Places in at Noon.		Temp. of		Notes.
		Lat. N.	Lon. W.	Air.	Wat.	
July 21,	9 A. M.	Halifax Harbour		56	53	Sailed at 8 A. M.
	11 A. M.	without the har-		53	52	
	4 P. M.	bour.		64	56	Land out of sight.
22	6 A. M.	43 12	64 6	56	50	I suppose we are on Roseway bank.
	Noon.			56	53	I suppose we are between Roseway
	4 P. M.			56	50	and Brown's bank.
	7 P. M.	41 57	65 1	56	54	July 22, 4 P. M. I suppose we are
24,	8 A. M.			56	50	on Brown's bank.
	10 A. M.			58	53	July 22, 7 P. M. I suppose we are
	Noon.	41 53	65 33	68	58	off do.
	6 P. M.			62	57	Tried current and found it NE. 1 knot
	Midnight.			62	56	no bottom in 80 fathoms.
25,	Noon.	40 44	67 32	64	58	Much Gulph weed, a whale 2 sharks
	4 P. M.			64	55	and many porpoises.
	6 P. M.			62	53	Bottom in 42 fathoms, no gulph weed.
	Midnight.	40 25	70 30	62	60	Bottom in 32 fathoms, flood N.
26,	3 A. M.			62	53	Bottom in do. fathoms, flood South-
	6 A. M.			60	57	ward.
	Noon.	40 23	71 10	64	60	
	4 P. M.			64	62	Bottom in 50 fathoms, flood N.
27,	3 A. M.			60	54	Bottom 35 fathom, flood Southward.
	7 A. M.	40 23	71 10	62	60	Stood West.
	Noon.			64	56	* N. B. by the soundings and the
	4 P. M.			64	54	Bottom 28 fathoms thermometer, I
	8 P. M.	40 29	70 51	65	59	suppose the true
	10 P. M.			64	55	Bottom 40 do. } long, to be as
	1 A. M.			64	56	do. 32 do. flood SE. } marked under
28,	6 A. M.	40 44	68 06	67	61	Do. 43 do. flood S W. the reckoning.
	Noon.			68	60	Do. 36 do. flood E. S. E.
	8 P. M.			69	64	Do. 65 do. worse ship, almost calm.
	10 P. M.	40 25	68 20	69	64	No bottom, I suppose we are within
	4 A. M.			68	63	the influence of the gulph stream;
29,	Noon.			68	63	in its eddy perhaps.
	10 P. M.	40 23	69 14	65	64	July 29, 4 A. M. bottom in 57 fathoms
	Noon.			67	66	flood W.
30,	4 P. M.			69	67	July 29, 10 P. M. bottom 45 do. the
	8 P. M.	40 29	70 51	69	68	water being warmer than in the
	Midnight.			70	69	same depth when I thought we
	3 A. M.			70	68	were near the shoals, I am induced
31,	4 A. M.	40 29	72 30	70	68	to believe that this bottom is that
Aug. 1,	9 A. M.			66	66	of the Coast.
	4 P. M.			68	66	July 30, 8 P. M. bottom 56 do. mud

July 31, 3 A. M. bottom 63 fathoms mud. The muddy bottom shows that we are within the shoals and banks of the Coast.

August 1, 9 A. M. Saw the land off Long-Island, bearing N.

August 1, 4 P. M. New-York Light House in sight, bearing West. N. B. since 2 A. M. we have been going from 5 to 7 knots *i. e.* about 50 miles West, which makes the longitude by thermometrical reckoning and soundings 73, 40 W. at noon, which turns out accurate, the land being in 74. 00 W.

Observations on a voyage from Halifax towards New-York.

1790. July 21. Sailed this morning from Halifax. The water at the harbour's mouth and just within Chebucta head, was at 53. but without it was at 52.—In landlocked places I have generally found the water warmer than in even greater depths, on the borders of the ocean.

22. When we lost sight of land the water was at about 56 but at 6 this morning it having cooled to 50 I suppose we are passing over Roweway bank.

At noon the heat of water had risen to 53 which makes me suppose we are over the ground between Roweway and the other bank called in some charts Brown's bank, and at 4 the water cooling again to 50 I suppose we are on this last mentioned bank.

24. The water at noon yesterday growing as warm as 56 I suppose we are on the S. E. edge of Brown's bank. As we afterwards hauled up more to the westward, and as the water at 8 this morning cooled to 50 again, I supposed we had returned more on the bank. But at noon the thermometer rose to 58. As it was calm, and the sun hot, I made some allowance for that cause, but supposed we had got off soundings, and as at 6 (the air being 6° cooler than at noon) it was at 57 I was confirmed in this.—It being still calm, and there appearing some gulph weed, we hoisted out the boat to try the current which we found to set N. E. nearly 1 knot. This puzzled me, I could not conceive ourselves to be in the gulph stream, because the water was not hot enough for that supposition, and as the iron pot by which we anchored the boat, was not at bottom though 80 fathoms of line were out, I thought the heat 57 fully accounted for by the depth of water; but about 7 when we had made a little way through the water, it became again calm, and we then saw and heard the ripple of a current as evidently as we could have expected over a shoal. I could not account for this any otherways than by supposing it to be the gulph stream, yet it appeared impossible that it should come so near the bank. Our Captain resolved to try again if there was a current here at a distance from this ripple and in a calm. He accordingly hoisted out the boat again and the current was found to set S. E. by S. about $\frac{1}{2}$ knot. The evidence of this various current in so short a space, the heat of the water not being raised to the heat of the stream, and our situation to the Northward made me conclude this to be the whirlpools of the eddy of the gulph stream just on the northern edge of it.

July 25, Noon.
Lat. 41. 53.
Long. 65. 33.

The water still continuing till noon nearly at the same temperature, and our course being to the West Southerly I concluded that our situation with respect to the stream was nearly the same as last remarked; this was confirmed by the passage of immense quantities of gulph weed, a deal of foam and mucus with a Whale two or three Sharks and a school of Porpoises in the course of the morning; but in the afternoon we fell off further to the Northward, and at 6 P. M. the water was from 55 to 53. no gulph weed to be seen, and in soundings of 42 fathoms. We tacked and stood south at 8 P. M. and I was astonished to find at midnight that the water was heated to 60, though the soundings were only 32 fathoms. Here again I could account for this only by the influence of the gulph stream, which the Capt. seemed to think probable, and tacked to the Northward, the wind being still at about W. and by 3 A. M. the thermometer fell to 53 with the same soundings, when we again tacked and stood to the southward. I then tried the heat of the water by the thermometer, regularly every hour, and by 5 P. M. it was up to 62. The soundings then were 46 fathoms:—we tacked and stood North, and at midnight it was again down to 55, at 3 A. M. to 54 the soundings then about 35 fathoms we then stood south when it returned to 60. Thus upon three successive tacks each way we cooled or warmed the water as we were standing either Northward or Southward from 6 to 9 degrees.—I could only account for this (the soundings varying but very little) by supposing that when we stood southward we got into the warm influence of the gulph stream, and as we stood Northward we got out of it. I do not think we got into the stream itself, because I should in that case have expected the water to have been much warmer, but probably we have been very near, perhaps upon the edge of it: and perhaps we have had a benefit instead of a disadvantage, by an eddy westerly current: that we have been near it, seems pretty clear, for when we warmed the water we saw plenty of gulph weed, and the weather was clear, when we cooled the water we saw no gulph weed and the weather was foggy.

July 27.

Perhaps we may be farther to the westward than we think: time and a good look out will discover,

July 30.
Lat. 40. 25.
Long. 70. 30.

Since the last observation relative to the stream and soundings I have kept the thermometer going almost every hour except when we were standing off the shore, and by examining the soundings according to those marked in Mr. Des Barres chart I have regularly traced them and if we were to suppose that a current was setting us about 1 knot per hour to the westward, the soundings would agree very well. When in about lat. 40. 25. we were standing off shore, we warmed

warmed the water to 64, and got 45 fathoms this heat I account for by the influence of the stream, it being greater than the proportion as to soundings, for in 40 fathoms farther toward the shore it was only 60. In looking over my journal from Boston to Virginia in Capt. Brace, I found that in nearly the same latitude the heat increased in about the same time from 52 to 59 but in a somewhat longer run. It was then October, it is now July, and the difference in the number of the degrees is easily accounted for by the season. By going more south and west in Captain Brace the water was raised to 67 when we found ourselves within the stream, it would at this season probably be upwards of 70. I therefore conclude that we are within the influence of the heat, but not the current of the stream, and I am in hopes to find that we have had that eddy current in our favour.

Aug. 1, 9 A.M. Having the land in sight we are confirmed in the supposition that a favourable current has carried the Ship faster than the Captain reckoned.

A P P E N D I X.

NOTES TO THE MARITIME OBSERVATIONS.

N^o. I.

Extract from the Journal of an Officer on board the British Ship of War, Liverpool, in November and December, 1775, on the Coast of Carolina and Virginia.

WHEN Cape Henry bore N. W. 160 leagues found a current setting to the Southward at the rate of 10 or 12 miles per day, which continued so till Cape Henry bore W. N. W. 89 or 90 leagues, then found a current setting to the N. E. at the rate of 32 or 34 miles per day, this current continued till within 33 or 30 leagues of the land on the above coasts, then it sets to the Southward and Westward, at the rate of 10 or 15 miles per day, till within 12 or 15 leagues of the land. This current which is only the eddy of the gulph stream, sets mostly S. W. or as the land lies.

In lat. 37. 50 sounded, and had 65 fathoms, fine sand, being 25 leagues from the land. In the same latitude and only 26 leagues from the land, had no bottom, with 180 fathoms.

From

From lat. 35. 30. to lat. 37. 00. there are no soundings 20 leagues from the land, but at 19 leagues distance there are soundings in 60 fathoms, at 18 there are only 35 fathoms, and from thence gradual soundings to the shore.

From Cape Hatteras to Cape Henry, the ground is fine sand, and to the Northward of Cape Henry, coarse sand with some shells among it.

N^o. II.

Extract from the Journal of an Officer on board the British Ship of War Liverpool, between 26th Sept. and 9th October, 1775.

IN lat. 45. 43. N. long. 21. 20 W. from Greenwich, found a current setting to the Southward 12 to 15 miles per day, which continued till we made the Island of Corvo, the North part of which is in lat. 39. 56. N. and long. 31. 8. W. from Greenwich by celestial observation, which agreed within 12 miles of the longitude per account, that being 30. 56. The variation of the compass off this Island is 18°. 19. W. and in sailing to the Southward and Westward, it gradually diminished, till we arrived in lat. 29. 00. N. long. 66. 40. W. where we had no variation.

N^o. III.

Extract from the Journal of an Officer on board the British Ship of War, Liverpool.

ON the 18 of October, 1775, in lat. 42. 4. N. long. 10°. 8. W. from the Island of Corvo, it bearing S. 75 E. distant 156 leagues, the sea being then very smooth it was suddenly agitated into a short irregular sea (without

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any shift or increase of wind) such as is generally occasioned by currents, and the next day we found we were 30 miles to the Southward of the reckoning. This current continued till the 22d of October, having then arrived in lat. 37. long. 13. 30. W. It set S. by W. $\frac{1}{2}$ W. $1\frac{1}{2}$ miles per hour.

Having a fair wind, and a good observation every day, and also good astronomical observations for determining the longitude, we had the greatest reason to depend on the authenticity of the above.

No. IV.

Extract from the Journal of an Officer on board the British Ship of War, Liverpool. July, August and September, 1775.

THE bank from Cape Cod extends almost as far as Cape Sable, where it joins the banks of Nova Scotia deepening gradually from 20 to 50 or 55 fathoms, which depth there is in lat. 43. In crossing the bank between lat. 41. 41. and lat. 43. the bottom is very remarkable; on the outside it is fine sand, shoaling gradually for several leagues on the middle of the bank, it is coarse sand or shingle with pebble stones, on the inside it is muddy with pieces of shells, and deepens suddenly from 45 or 48 to 150 or 160 fathoms.

No. V.

In lat. 44. 54. N. long. 53. 19. W. on board the British Packet Chesterfield, Capt. Schuyler. July 10, 1790.

THE Captain caught a codfish, and in a few minutes after it was opened and gutted, I put the thermometer into its belly, the instrument marked 39 when in air
it

it was 57, and in water on the surface 52. Depth 46 fathoms.

In lat. 44. 52. N. long. 54. 57. W. July 11, 1790.

THE people caught several codfish and hallabot, the thermometer was put into three codfish and one hallabot successively, the instant they were hauled up, and the instrument marked 37 in every case. The air was at 57, and the water at the surface was 53. The first experiment was repeated after the fish was gutted, and it then marked one degree warmer. I thence conclude that the difference between the two experiments was owing to the time the fish was in the air before the trial, and that in all the instances the animal heat of the fish was about 16° colder than the water at the surface; and as it seems natural, from analogy, to suppose that animal heat is at least as warm as the fluid in which the animal lives, I conclude that the water at the bottom was as cold as 37 *i. e.* 16° colder than at the surface. In a former voyage it was found by decisive experiment, that near the coast in very hot weather the water at the bottom in 18 fathoms was 12 degrees colder * than at the surface.

Another reason to suppose that the water was colder at bottom than the animal heat, was the great distension of the cods sounds when they were opened, although they had sent out innumerable bubbles of air in the passage up; the air, therefore, within the sound, must have been much more compressed, (either by cold or the power of the animal) below, than above, where it was at 37. Several fish that had been hauled up to the surface of the water, and then dropped from the hook, swam light on the surface

N 2

till

* See Philosophical Transactions, Vol. II. page 329.

till they recovered their vivacity, although they lost much air in coming, up the specific gravity was therefore much less than at bottom, and this was probably owing to the distension of the sound. That fish rise and sink in the water, by this power of increasing and diminishing their bulk, and consequently their specific gravity, is well known to naturalists, but I was pleased to see the truth of that fact confirmed by these experiments.

JONA. WILLIAMS, JUN.

Nº. XI.

An account of the most effectual means of preventing the deleterious consequences of the bite of the CROTALUS HORRIDUS, or RATTLE-SNAKE. By BENJAMIN SMITH BARTON, M. D.*

Read Aug.
19, 1791.

DURING my passage through several of the western settlements of Pennsylvania, and the adjoining States, in the year 1785, I made it an object of attention to acquire every possible information respecting the effects of the poison of the RATTLE-SNAKE, and the methods of prevention, or of cure, which are commonly employed in those parts of our country. A very considerable number of vegetables were either mentioned, or shown, to me, all of which, I was assured, *were good for the bites of Snakes*. Without being much of the skeptic

* I think it proper to confine my remarks to this species of RATTLE-SNAKE, because it is that with which I am best acquainted; because it is the most common species in those parts of our country which are best known to me, and because I believe it is the most deleterious species that has yet been discovered within the limits of the United-States. I have little doubt, however, that the plan which I have recommended, and the remarks which I have made, will equally apply to the *Crotalus miliarius*, the *Crotalus Durissus* and the other species of this formidable family of serpents which are described by Linnæus, and by other writers.